



CERCLA Health Risk Assessment Overview

(in just about a ½ hour)

Mr. Lawrence V. Tannenbaum

Senior health risk assessor

Army Institute of Public Health

U.S. Army Public Health Command

For the Picatinny Arsenal RAB

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Agenda

1. review of a handful of relevant acronyms
2. What is risk, risk assessment (r.a.), etc.?
3. the r.a. process
4. some attention to the State's (soil) clean-up process

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**Just a few acronyms;
sorry, but it's unavoidable**

CERCLA = Superfund

- CERCLA = **C**omprehensive **E**nvironmental **R**esponse, **C**ompensation, and **L**iability **A**ct.

Picatinny Arsenal is a **Superfund** '**N**ational **P**riorities **L**ist' (**NPL**) site. The **NPL** is a list of the nation's most contaminated sites (the "worst actors").

Picatinny Arsenal was added to the **NPL** in 1990.



To put things into perspective . . .

Status	Non-Federal (General)	Federal	Total
Proposed Sites	47	4	51
Final Sites	1165	157	1322
Deleted Sites	370	17	387

[es](#)

Just a few more acronyms

- **NPL** sites must follow the **N**ational **C**ontingency **P**lan (**NCP**), and must thereby, have CERCLA risk assessments done. (The **NCP** is actually The **N**ational **O**il and **H**azardous **S**ubstances **P**ollution **C**ontingency **P**lan).
- The U.S. EPA risk assessment guidance to be followed for NPL sites is . . . **R**isk **A**ssessment **G**uidance for **S**uperfund (**RAGS**).

United States
Environmental Protection
Agency

Office of Emergency and
Remedial Response
Washington DC 20460

EPA/540/1-89/002
December 1989

Superfund

PA

Risk Assessment
Guidance for Superfund "RAGS"
Volume I
Human Health
Evaluation Manual
(Part A)

Interim Final

The **B**aseline **R**isk **A**ssessment (**BRA**)

BRA = the assessment that tells you about site risks . . . with the site “*as is*” (i.e., without any remedial efforts taken).

We want to know the
“**baseline**”
risk.

Before we can discuss what risk assessment is, we have to discuss & define “risk**” itself!**

- Everyone knows what risk is.
- Each of you took some (many?) risks today.
- Every aspect of life has an element of risk associated with it.

Let's define "risk" as: the probability of there being a negative outcome (to something you do, or a behavior that you have).

- Risk is measureable or estimable.
- Risk is necessarily negative; it's the thing that you **DON'T** want to happen.

types of risk

activity

playing the stock market

playing sports

getting married

gambling

smoking

fishing at a contaminated lake

Soldier training at a former

risk

losing your investment
injury

getting divorced

losing your shirt

you name it!

potential health effects

potential health effects

And what's “**risk assessment**”?

- It's the process or method of determining how much risk there is associated with an action or behavior.

Health Risk Assessment

- For our needs, we're talking about:
 "chemical exposure health risk assessment"
- A proper CERCLA risk assessment consists of:
 - a) a human health risk assessment, and
 - b) an ecological risk assessment

We want to know the probability of a living thing developing a health effect of interest from having chemical exposures at a contaminated site.

Examples of Superfund-type issues

- There are chemical residues in the soil in the front yard of a home someone just purchased. Can the owner plant flowers there?
- Through the Army's testing of munitions, over the years, hundreds of explosive rounds have landed in a lake on an installation. Is it safe to eat the lake fish?
- Organic solvents (e.g., trichloroethylene) have shown up in the last two groundwater monitoring sampling rounds in your township. Is it safe to shower at home?

“Risk Management”

- Since most car accidents in local traffic occur at intersections, drivers should speed up as they go through. Spending less time in intersections will reduce the number of accidents overall.

Real bad idea



- Since wearing a bike helmet can reduce the chance of injury, ensure that every biker wears one.

Maybe not; helmets can also provide a false sense of invulnerability.

Putting it all into perspective

risk communication

- **Risk assessment**

risk communication

- **Risk management**

risk communication

The four-step human health risk assessment ("RAGS") process

1. Data Collection / Hazard I.D.
2. Exposure Assessment
3. Toxicity Assessment
4. Risk Characterization

***Bear in mind that NJDEP has a very different approach; to be discussed near the end.**

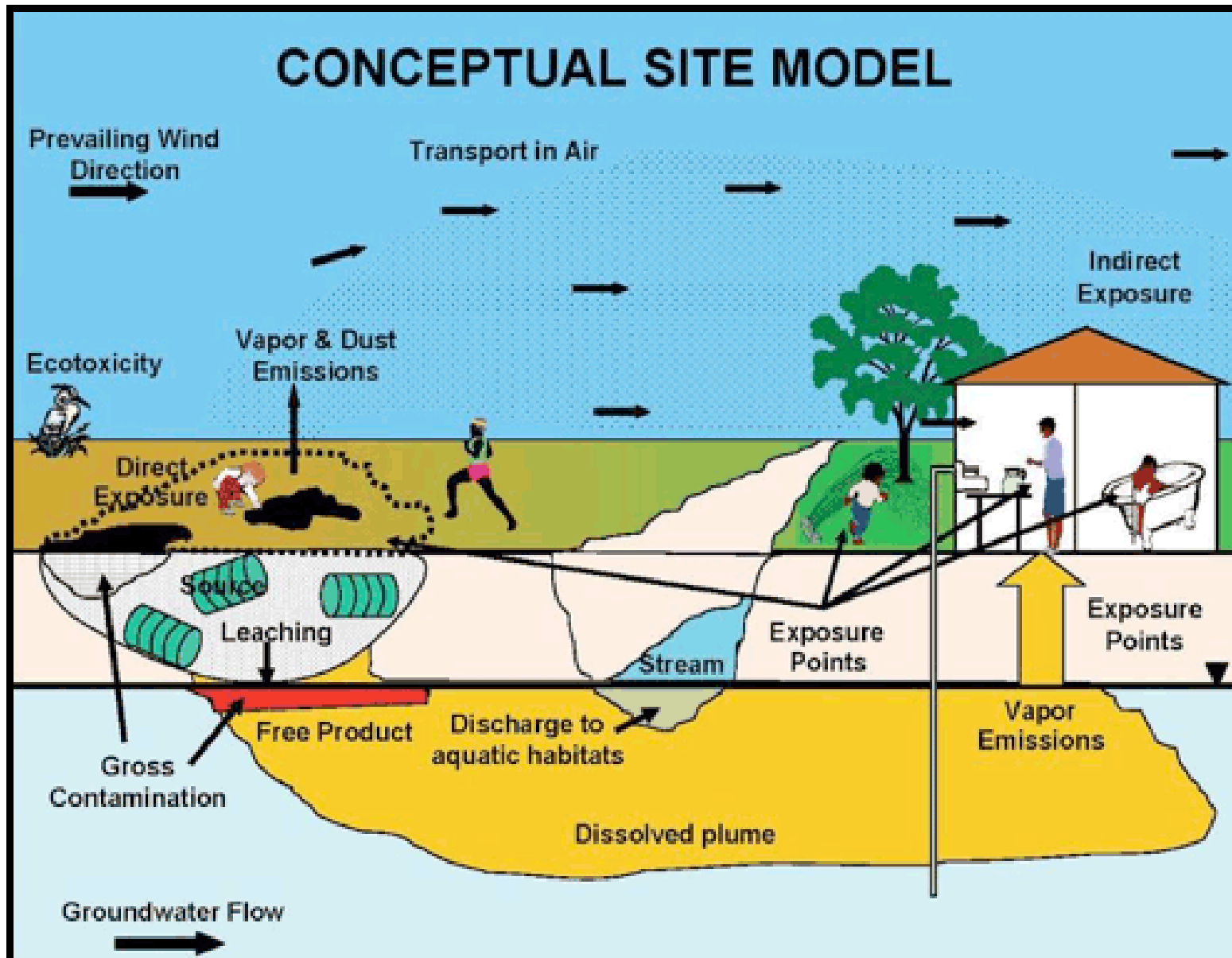
The four-step health risk assessment process (or the “RAGS methodology”)

- 1. Data Collection / Hazard I.D.**
- 2. Exposure Assessment**
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Data Collection / Hazard I.D.

- Acquiring reliable chemical release and exposure data (e.g., soil samples, depth to groundwater) in support of quantitative human health r.a.'s (HHRA) at hazardous waste sites.



Types of chemicals (to sample)

1. Metals / inorganics / priority pollutants

Ag, Al, Ba, Be, Cd, Cu, Pb, Hg, Ni,
Sb, Se, Tl, Zn

- These are naturally occurring.
Almost always we're working in units of mg/kg or "ppm" (parts per million).

Types of chemicals

2. Organic compounds

These include:

- volatile compounds (aka VOCs),
 - semi-volatile compounds (aka SVOCs),
 - PCBs & pesticides
- These are not naturally occurring, but rather anthropogenic in nature.
- Frequently they ~~are present~~/measured in ug/kg or “ppb” (parts per **b**illion).

Types of media (to sample)

1. Soil
2. Surface water
3. Sediment
4. Groundwater
5. Air
6. Living tissue (e.g., plants, worms, mice)

How do we know that a chemical might be present at a problematic concentration - and worthy of carrying through an r.a.?

The answer is through . . . **screening**.

There are several screening procedures to apply to arrive at your:

“Chemicals of Potential Concern” (**COPC**) list.



COPC selection and refinement

every detected chemical at the site



**true
CO(P)C
s**

Screening for any chemical -
inorganic or organic:
the 'frequency of detection' (f.o.d.) screen

- A chemical needs to be present in 5% of the samples to be retained for further screening as a COPC.

Chemical f.o.d.	Drop or retain as a COPC
4/32	retain
3/80	drop
2/35	retain
2/40	drop
1/19	retain

Screening for inorganic COPCs

- Here's a helpful screening tool:

Compare the maximum onsite chemical detection with a value that is 2x the mean chemical concentration in the site background.

If the max detection is higher, the chemical is retained as a COPC.

Screening for any chemical - inorganic or organic:

- Compare the maximum detected concentration against a risk-based concentration (**RBC**).

This is done in conservative fashion. For example, we'll compare the highest detection with a concentration that equates with a one-in-a million risk of getting cancer. If the highest chemical detection on site is less than the **RBC**, we can be sure that chemical is not a COPC; we can drop it out of the r.a.

The four-step health risk assessment process (or the “RAGS methodology”)

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- 2. Exposure Assessment**
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Exposure assessment

- **Who** specifically is exposed?, i.e., Who are our site human receptors?
- office worker, construction worker, trespasser, on-site resident, off-site resident, etc., etc.
- **How** and **How often** are they exposed? What routes of chemical exposure are to be considered?
- There are as many as three routes: ingestion, inhalation, and dermal contact

Table 3.	Exposure pathway analysis						
	RECEPTORS						
Pathway	Current Site Use					Future Site Use	
	child recreator	adult recreator	grounds-keeper	student	teacher	construction worker	resident
Surface Soil							
Incidental ingestion	●	●	●	●	●	○ ¹	○ ¹
Dermal contact	●	●	●	●	●	○ ¹	○ ¹
Inhalation of VOCs	○	○	●	○	○	○ ¹	○ ¹
Subsurface Soil							
Incidental ingestion	x	x	x	x	x	●	●
Key: ● pathway complete; to be assessed ○ pathway complete; not to be assessed							
Dermal	x	x	x	x	x	○ ¹	exposure to ‘total soil’ ●

Key: ● pathway complete; to be assessed
○ pathway complete; not to be assessed
x pathway incomplete; not assessed
¹ exposure to 'total soil'

To consider . . .

- Reasonableness
- BPJ (that's '**B**est **P**rofessional **J**udgment')

The four-step health risk assessment process (or the “RAGS methodology”)

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Toxicity Assessment

- What toxic effects concern us?
- 2 categories: cancer & systemic effects
- There are also acute and chronic effects.

In the main, we're concerned about chronic effects.

- How toxic are the COPCs?

What types of toxic effects are we concerned about?

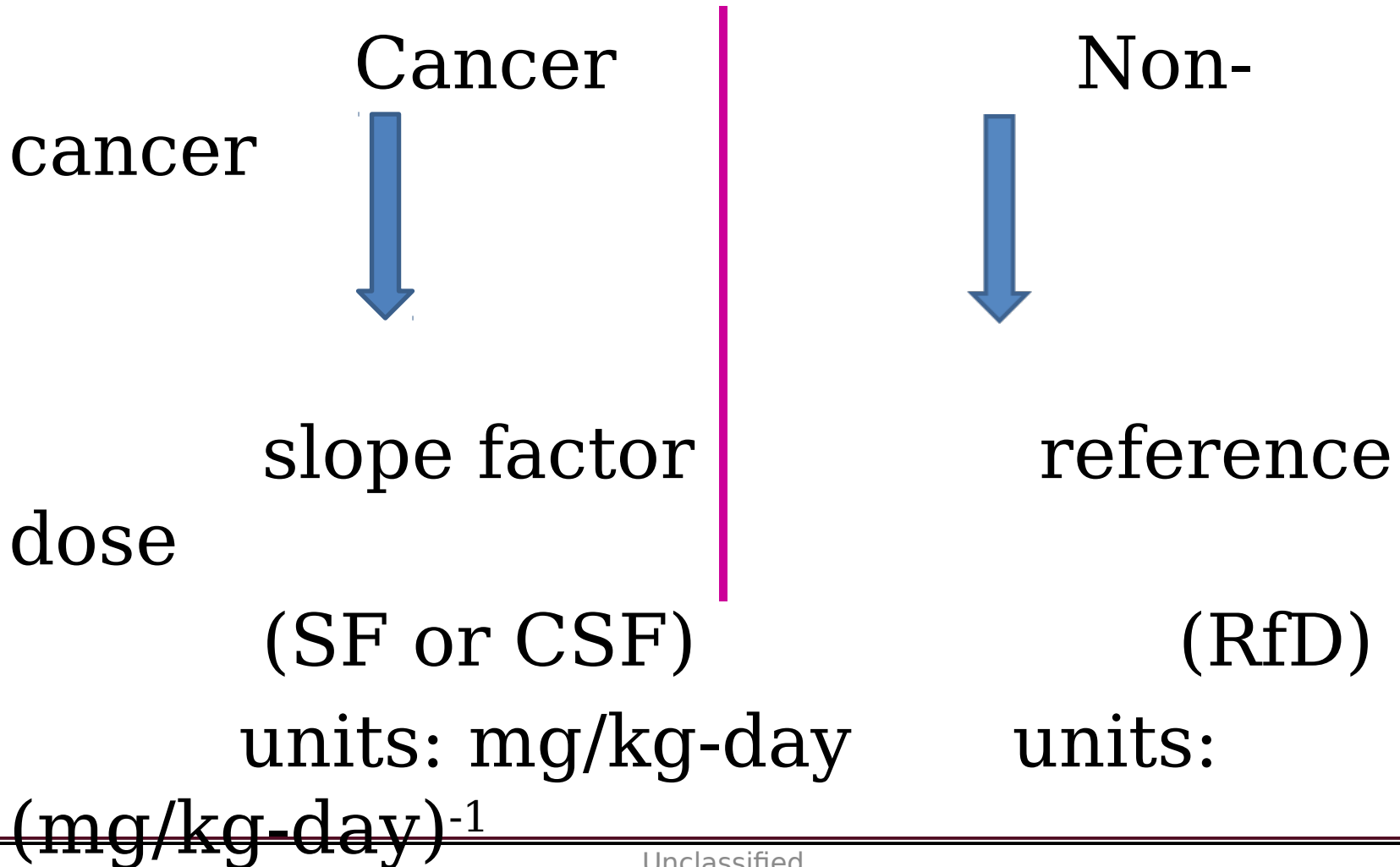
- Cancer

- There are many forms of this disease.

- Systemic effects ('non-cancer effects')

- heart arrhythmia
- liver lesion
- kidney disease
- alopecia
- dermatitis

Expressing toxicity: toxicity factors



**And where do toxicity factors
(mostly) come from?**

**Did I hear someone say . . .
'uncertainty'?**

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Risk Characterization

In this step, all of the information we assembled earlier is used to **quantitatively** express the risk assessment findings.

For the cancer assessment, we'll compute the “incremental lifetime cancer risk” (**ILCR**).

For the non-cancer assessment, we'll compute:
the “hazard quotient” (**HQ**) and/or
the “hazard index” (**HI**).

For both endpoints, we pair up the chemical intake and the appropriate tox factor/expression of toxicity.

The Intake (**I**) Equation:

$$I \text{ (mg/kg-day)} = \frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$$

where:

CS = (the chemical) concentration in soil (mg/kg)

IR = ingestion rate for soil (mg/day)

CF = conversion factor (10^{-6} kg/mg)

FI = fraction ingested (of chemical) from contam. source;
unitless

EF = exposure frequency (days/year)

ED = exposure duration (years)

BW = body weight (kg)

AT = averaging time (same as ED for noncancer; always 70
years

for cancer; always in units of days no matter what!)

Once you have the **intake** computed,
computing risk or hazard is easy.

Cancer **risk**: $I \times SF$

Noncancer **hazard**: $I \div RfD$



Risk assessment outcomes:

How much cancer risk?

The “beloved” 2 order-of-magnitude risk range . . .



10^{-4}

10^{-6}

(risk level of 1-in-10,000)

(risk level of 1-in-

1,000,000)

the “trigger”

the “point-of-

departure”

Risk assessment outcomes:

How much non-cancer hazard?

HQ < 1.0

HQ = 1.0

HQ > 1.0

If a pathway had a computed HQ of 3.1,
would that pose a problem?

Summing ILCRs

Example: human exposure (adult future resident)

medium	ingestion	dermal	inhalation	ILCR _{total}
soil	8.0E-06	8.3E-05	2.0E-08	9.10E-05
s.w.	4.1E-08	2.2E-06	N/A	2.24E-06
g.w.	3.4E-04	6.8E-05	2.3E-05	4.31E-04
pathway	3.48E-04	1.53E-04	2.30E-05	5.24E-04
		Unclassified		44

What about summing chemical-specific ILCRs?

- It's fine to do, as varied as the forms of cancer may be. It's EPA's thinking that there's a common denominator to all cancers, namely that in each case, cells have gone awry.

What about summing chemical-specific HQs?

(Example: human exposure to soil)

chemical	target organ	HQ	HQ _{fin}
antimony	blood glucose	0.6	
arsenic	skin	9.1	9.1
cadmium	kidney	0.8	
ethylbenzene	kidney; liver	3.1	
manganese	CNS	5.0	5.0
		HI _{init} 18.6	

Now you are all
certified health risk assessors!!
Congratulations!!

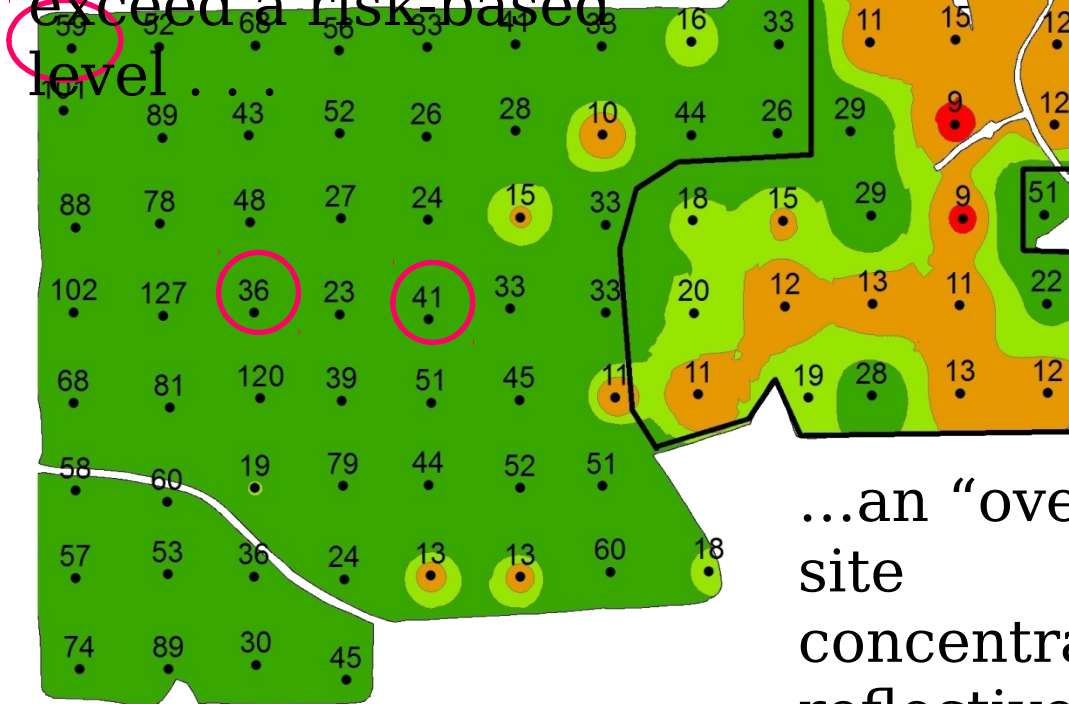
- **But** . . . we're not quite done yet.
- NJDEP does not follow USEPA risk assessment guidance.
- With regard to soil, NJDEP applies
“New Jersey
Soil Remediation Standards
Guidance”

In brief, the relevant criteria are applied directly to detected soil concentrations, point-by-point.

- Residential Direct Contact Soil Cleanup Criteria
(RDCSCC)
- Non-Residential Direct Contact Soil Cleanup Criteria (NRDCSCC)
- * The State's approach can lead to a radically different determination!

Consider . . .

While individual sample locations might have concentrations that exceed a risk-based level . . .



...an “overall representative site concentration”, much more reflective of the site condition, might **not** indicate an exceedance or a potential health effect at all



Thanks for being a great audience!

Got any questions?